International Journal of Life Science and Agriculture Research

ISSN (Print): 2833-2091, ISSN (Online): 2833-2105

Volume 03 Issue 03 March 2024

DOI: https://doi.org/10.55677/ijlsar/V03I3Y2024-02

Impact Factor: 6.774 , Page No : 124-131

Estimating the Indicators of productive and Marketing Efficiency of the Green Pepper under the Protected Cultivation System in Baghdad Province

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ABSTRACT: The Iraqi agricultural sector is of great importance among other economic sectors, this sector is still facing several challenges in the field of its tasks by providing food for members of society, providing the necessary foreign currencies to finance development plans, and the incompatibility of seasonal production with optimal import periods, which makes vertical expansion one of the necessary means for development this sector, and the trend to the protected agriculture system, as one of the means of agricultural intensification. The research aims to study the productive and marketing efficiency of the green pepper crop under the protected cultivation system, by estimating the production cost functions, estimating the optimal economic size, calculating some financial evaluation criteria for this crop, and identifying the most important production and marketing obstacles facing the farmers of this system. Through estimating the results of the productive and economic indicators of the green pepper in greenhouses, it became clear that there is an economic efficiency in its production, where the return-to-cost ratio was greater than one. The results of estimating the production cost function of green pepper indicated that the crop does not achieve the required level of efficiency in its production, where the optimal size of production was about 3.3 tons, while the average production of the selected sample was about 2.73 tons. The estimated results also indicated that the total marketing costs of green pepper amounted to about 13,244,000 Iraqi dinars, and the marketing efficiency of the crop was about 76%.

Published Online: March 02, 2024

KEYWORDS: Optimum size of production, Cost efficiency, Marketing margins, Pepper crop, Greenhouses.

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INTRODUCTION

Agricultural development is an integral part of economic development in most countries of the world. Most studies indicate that the majority of developed countries faced their problems (such as increasing population, increasing demand for agricultural commodities, limited resources, etc...) and made progress in their economy, as a result of development, which accompanied its cultivation. So the development of the agricultural sector and the modernization of its production methods became not only a goal sought by developing countries, but also an urgent necessity for the establishment and success of economic development in general (Jassam, 2017). Agriculture is one of the main economic activities that contribute to the national economy, and food security is linked to national security, where achieving food security depends primarily on providing food from local agricultural production, and the advancement of the agricultural sector contributes to diversifying the economy, alleviating poverty, improving the trade balance, and achieving the movement of most sectors associated with it. In other words, the development of the agricultural sector contributes to combating unemployment, reducing the volume of imports, the development and advancement of society, and strengthening the national economy, in addition to the fact that the local producer is safer and more reassuring about the health safety of the consumer compared to the importer (Samir and Ibrahim, 2010), since most of the diseases of the era are related to food and food consumption, and the development of the agricultural sector reflects positively on improving the environmental reality.

In light of the difficulties facing agricultural development in Iraq, which are represented in the limited land and water resources, as well as the huge investments required for horizontal agricultural expansion, and the long payback period for these investments, which necessitates the need to increase the unit productivity of the land area, in addition to the fact that the limited economic resources impose the need to work to increase the supply of agricultural products with the available economic resources, to meet

the growing and continuous demand for food (Hassn, 2022). Therefore, the use of modern technologies in the agricultural sector has become one of the most important axes of vertical agricultural development, which necessitates work to encourage the use of modern technology in Iraqi agriculture. Vegetable crops in Iraq take an advanced economic position among other food crops, due to the steady increase in vegetable consumption as a result of increasing health and nutritional awareness, and what increases the role of vegetables in raising the nutritional level is their low price when compared with other sources of food, where it can be grown in small areas and even in the vicinity of homes. Vegetables can grow in a short period of time and collect more than one crop during one season, which increases the importance of expanding the cultivation of vegetable crops and increasing their production as they give more profits than other crops, and achieve quick farm returns (Mahmoud and El-Sanosy, 2015).

Due to the different types and varieties of vegetable crops, their different requirements are strongly differentiated, whether in terms of fixed or variable capital, where it is noted that the needs of production requirements are relatively large, as well as the need of hours of manual labor in the various stages of production, where this need is linked to a large extent the nature of agriculture and the different types and varieties of vegetable crops. The production of vegetable crops, like the rest of the crops, requires mixing the elements of agricultural production in an optimal manner that achieves the exploitation of the available economic resources, taking into account the internal and external requirements of the national economy (Abdel Fatah and Amin, 2016). The protected farming system is a good way to use modern technologies and patterns in agriculture, in order to achieve a high economic return by increasing production and shortening the unit area used for agriculture and producing high-quality agricultural crops and free of pollutants in good quantities and qualities in the off-season (Saied and E.Bayoumi, 2019), as well about saving the quantities of water used in agriculture compared to the quantities of water consumed by traditional open agriculture, which makes protected agriculture at the forefront of solutions, means and technologies needed to face the obstacles of the agricultural sector in Iraq.

Based on the subject problem, the research assumes that there is a decrease in the level of productive efficiency of the green pepper crop under the protected cultivation system, due to the inability of farmers to exploit the optimal production capacities in producing the crop, in addition to the low marketing efficiency of the crop due to a decrease in marketing performance, which affects the high production and marketing costs for this crop, which in turn leads to reduced profits and marketing margins. The research mainly aims to estimate and study the indicators of the productive and marketing efficiency of the green pepper crop under the protected cultivation system in Baghdad province, through estimating the cost functions for this crop, and then estimating the optimal economic size, in addition to measuring the marketing efficiency of the crop.

MATERIALS AND METHODS

Conceptual framework

The optimal volume of production is determined at the level at which the average total costs are as low as possible, and at this volume the marginal total costs are equal to the average total costs, and the share of the production unit in the average variable costs is as low as possible, and the efficiency of production factors is the greatest can at this level of production. As for maximizing the profit function, the rational producer achieves its maximum profits when the marginal cost is equal to the marginal revenue per unit produced. Since costs depend on the volume of production and all prices are fixed, the cost function is as follows (Althamer, 2016):

$TC = TFC + f(Q)$

That is, production costs are a function of the volume of production plus fixed costs, and profit can be expressed as a function of the volume of production as follows:

$\boldsymbol{\pi} = P.Q - f(Q)$

The optimal volume of production can be determined by maximizing the profit function above, that is, the maximum limit of total profit is achieved when the first derivative of the profit function is equal to zero, that is, the necessary condition for maximizing the profit function requires that the optimal volume of production is that volume at which marginal costs are equal to the price, the sufficient condition for maximization is (Kay and etc., 2015):

$d^2 \boldsymbol{\pi}/d^2 Q = - d^2 TC/d\, y^2 < 0$

That is, profit maximization requires that the second derivative of the cost function be positive, and that the market equilibrium of the producer in the perfect competition market is achieved when the marginal cost is equal to the marginal revenue, and the status of the producer is determined according to the prevailing price level in the short-term market, if the price is higher than the average total costs, the producer achieves an extraordinary profit, and the maximum profit is achieved when the marginal cost equals the marginal revenue. If the price is low and less than the average total costs, then the producer achieves a loss, and its loss in the short term is as low as possible (Newnan and etc., 2015). To determine the optimal behavior of the product in achieving its objectives, the cost function is adopted in determining the optimal size of the production unit that achieves economic efficiency (which is the size that achieves the lowest cost or that achieves the highest profit per unit of production).

Productive efficiency, or what is called technical efficiency, means the optimal use of available resources, the production of the largest amount of goods and services using the production elements available in society. The productive efficiency measures the degree of success of the economic unit in exploiting the resources available to it for produce the goods and services that it specializes

in producing, and thus the output is maximized relative to per unit of input used (Alwan and al atabe, 2010). Productive efficiency can be estimated in two ways (Ali and Farhan, 2015):

i. Equating the marginal cost function with the average variable cost function.
ii. Find the minimum limit of the average variable costs function.

Cost efficiency can also be calculated by dividing the total costs of the actual level of production by the total costs of the optimal level of production, according to the following equation (Mazrou and Eladawy, 2020):

$CE = TC^A \div TC^O$

Where: CE = Cost Efficiency.

TC^A = Total costs at the actual production level.

TC^O = Total costs at the optimum level of output.

Where cost efficiency is achieved when the quotient is one, and if the result is less than or greater than one, it is inferred that the crop did not achieve the required level of productive efficiency.

Marketing efficiency is defined as maximizing the ratio between outputs and inputs, as outputs refer to marketing income resulting from consumer satisfaction of goods and services, and inputs refer to the costs of the various elements involved in marketing operations such as labor, capital, and management. Thus, it is clear that the most important components of marketing efficiency are the level of performance of marketing services, and the costs of performing these services (Thamer, 2013). If the marketing system includes a decent level of service, but it is expensive, this does not necessarily mean an improvement in marketing efficiency. Marketing efficiency may also not be achieved when marketing costs are low, but the level of performance of marketing services is not good or ineffective. This means that any changes that lead to a reduction in the costs of conducting a marketing task without being accompanied by a decrease in consumer satisfaction would increase marketing efficiency, but if these changes lead to a reduction in marketing costs in addition to a decrease in consumer satisfaction, this may lead to a decrease in marketing efficiency (Zaidan and Khater, 2013).

The process of measuring marketing efficiency is an important step in order to improve it, and for this, it is necessary to identify some indicators by which the efficiency of the marketing system for agricultural crops can be judged, in light of the problem of measuring the consumer benefit of the final outputs of the marketing process, which represents the main obstacle to measure agricultural marketing capacity (Amre, 2018). Marketing efficiency is measured using the following equation (Abdul Hamid and etc., 2017):

$$ME = 100 - \frac{MC}{MC + PC} \times 100$$

Where: ME = Marketing Efficiency.

MC = Marketing Costs.

PC = Production Costs.

It is also possible to measure the efficiency of the marketing system for some agricultural crops through the following equation (Al fraji and etc., 2016):

$$ME = 100 - \frac{MM}{MM + PC} \times 100$$

Where: ME = Marketing Efficiency.

MM = Marketing Margins.

PC = Production Costs.

The process of measuring marketing margins is the first step to identifying the total marketing costs incurred by the flow of goods and products from the areas of production to the places of consumption, passing through the marketing markets (tracts) until they reach the hands of the final consumer (Al-Dabbagh, 2014). The marketing margin represents the difference between the price at which the product is sold and the price paid by the consumer at the level of one marketing stage or at the level of the entire marketing route. The evaluation of marketing margins is considered one of the most widespread methods for evaluating market performance and marketing efficiency. It includes the costs of necessary services depending on the type and nature of the commodity and the transfer of the commodity from the producer to the consumer (Bipradas, 2014) & (Ahmed, and Hassan, 2016):

Marketing Margin = marketing costs + profits

Or Marketing Margin = the price paid by the final consumer - the price at the farm door

The benefit of calculating marketing margins is as follows (Al-Kiswani, 2018):

i. Calculating the costs of marketing services added to the commodity.
ii. Calculating brokers' profits.
iii. Clarifying the relative importance of marketing costs items.
iv. Estimating the farmer's share from the consumer's price.
v. Estimating the share of marketing margins from the consumer price.

Study Sample and Analysis Method

The research relied on the primary data collected by designing a questionnaire form for a random sample of 60 farmers out of approximately 600 farmers of the crop under study in the agricultural season 2022-2023, where the sample farmers were selected according to their distribution to the various agricultural units of Baghdad Province, namely: Division Mahmoudiyah Agriculture, from whom 40 farmers were chosen, and Al-Rasheed Agriculture Division, from whom 20 farmers were chosen. The research was based on the use of the descriptive and quantitative statistical analysis methods, with the estimation of some mathematical equations, productive efficiency criteria, production cost functions in its cubic form, some financial evaluation criteria for the crop under study, and the interpretation of the results of analysis and measurement in the light of economic, statistical and econometric logical.

RESULTS AND DISCUSSION

Productivity and Economic Indicators of Green Pepper Crop under Protected Cultivation System

By reviewing the economic indicators per dunum for the green pepper crop under the protected cultivation system in Baghdad province, as shown in Table 1, it was found that the productivity rate was about 2.73 tons, with an average price of about 537 thousand dinars per ton, and the total revenue per dunum was about 2,156,667 dinars, while the total costs of producing a dunum amounted to about 2,040,942 dinars, achieving a net return of about 115.7 thousand dinars per dunum. The profitability of the spent dinar was about 0.057 dinars, while the return on investment per dinar was about 1.057 Iraqi dinars, which means that there is an economic efficiency in the production of the pepper crop because the rate of total return to the total cost rate is greater than one, even if by a small amount or difference.

Table 1. Productivity and economic indicators of green pepper crop under protected cultivation system

No.	Productive and economic indicators	The unit of measurement	Value of indicator
1	production rate	Tons	4
2	area rate	Dunum	1.46
3	productivity rate	Tons/dunum	2.73
4	Average selling price	Dinars / ton	537500
5	total revenue rate	Dinars / dunum	2156667
6	fixed cost rate	Dinars / dunum	1383879
7	Variable cost rate (pre-marketing)	Dinars / dunum	657063
8	Total production cost rate	Dinars / dunum	2040942
9	net revenue	Dinars / dunum	115725
10	The profitability of the spent dinar	Dinars	0.057
11	Return on investment spent dinar	Dinars	1.057

Source: Calculated by researchers based on field survey data, and the following equations:

Net revenue = total revenue rate - total cost rate
The profit of the spent dinar = net revenue ÷ total cost rate
Return on investment spent dinars = total revenue rate ÷ total cost rate.

Estimating the Optimal Production Size and the Maximum Profit Size of the Green Pepper Crop under the Protected Cultivation System

After analysing the data related to the production and costs of green pepper crop under the protected cultivation system at the level of the study sample in SPSS, it became clear that the cubic formula is more suitable for the studied relationship based on economic, statistical and econometric tests, where the estimated model took the following form:

$TC = 2181427.711 + 441604.277Q - 399358.663Q^2 + 59759.066Q^3$

whereas:

TC = Total cost of green pepper in greenhouses (ID/dunum). The total fixed costs included the cost of the depreciation of the greenhouse, irrigation networks, detergents, appliances, machinery, equipment, irrigation basins and water tanks, the cost of land rent, the interest cost on the capital invested in the greenhouse, and the opportunity costs for the farmer and his family members. As for the variable production costs, they included plowing wages, climbing ropes, plastic house dishes, iron wire, plastic, chemical and organic fertilizers, seeds, pesticides, irrigation water, and hired labour.

Q = Quantities produced of green pepper in greenhouses (ton/dunum).

It is clear from the model that the estimated relationship of the total costs and production volume of the pepper crop inside the greenhouses according to the cubic formula came in agreement with the economic logic in terms of the signs of the estimated constants. From the above estimated cost model, the marginal cost and average cost functions of the green pepper crop were calculated, as follows:

$MC = 441604.277 – 798717.326Q + 179277.198Q^2$

$AVC = 441604.277 – 399358.663Q + 59759.066Q^2$

According to these functions, it was possible to measure the indicators of the productive efficiency of the crop under study, which are:

i. **The optimal volume of production:** The optimal volume of production, which reduces the production cost to the lowest possible extent, was calculated by equating the average variable cost function with the marginal cost function, as follows:

$441604.277 – 399358.663Q + 59759.066Q^2 = 441604.277 – 798717.326Q + 179277.198Q^2$

$441604.277 – 399358.663Q + 59759.066Q^2 – 441604.277 + 798717.326Q - 179277.198Q^2=0$

$399358.663Q – 119518.13Q^2 = 0$

By extracting a common factor, and performing mathematical operations, we get the optimal volume of production, as follows:

$Q = 399358.663 / 119518.13 = 3.3$ Tons/ dunum

So the optimal volume of green pepper production in greenhouses was about 3.3 tons/dunum, while the average actual production volume for the study sample was about 2.73 tons/dunum, and this means that the efficiency rate in producing the crop amounted to about 83%.

ii. **Cost efficiency:** The cost efficiency of producing the green pepper crop was estimated according to the following equation:

$$CE = TC^A \div TC^O$$

$$CE = 1626510.08 \div 1437267.54 = 1.13$$

This means that pepper growers did not achieve the required level of efficiency in the production costs spent on producing the crop, where the amount of costs at the actual production volume exceeds the costs at the optimal production volume by 113%.

iii. **Profit-Maximizing Production:** This economic indicator was calculated by equating the marginal cost function with the average selling price of the crop (537500), assuming that the farmer works under conditions of perfect competition (MC=MR=AR=P), as follows:

$441604.277 – 798717.326Q + 179277.198Q^2 = 537500$

By order of the equation, it yields:

$179277.198Q^2 – 798717.326Q – 95895.723 = 0$

This equation is solved by the constitution method to extract the value of Q, which represents the amount of production that maximizes profit:

$$Q = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

$$Q = \frac{798717.326 + \sqrt{(-798717.326)^2 - 4(179277.198)(-95895.723)}}{2(179277.198)}$$

$$Q = \frac{798717.326 + 1060953.22}{358554.396}$$

$Q = 5.186$ Tons/ dunum

It is clear that the average volume of green pepper production in greenhouses, which maximizes profit, was about 5.2 tons/dunum, while the average actual production volume of the sample was about 2.73 tons/dunum, which means that the efficiency rate in producing the crop amounted to about 53%, which is less than its counterpart at optimum output level.

iv. **The net return at the level of the optimal and profit-maximizing production volume:** Table 2 shows that the net return achieved at the level of the optimal production volume and the profit-maximizing production volume amounted to about 336482.46 and 713285.54 Iraqi dinars each, respectively, while the net return achieved at the actual production volume of the sample was about 115725 Iraqi dinars, this means that the profits achieved according to the optimal and profit-maximizing production volume exceed the profits achieved according to the actual production volume of the study sample by 220757.46, 597560.54 Iraqi dinars each, respectively.

Table 2. Profits achieved at the actual, optimal and profit-maximizing production level of the green pepper crop

Indicators	Actual production level	Optimal production level	Profit-maximizing production level
Production quantity / ton-dunum	2.73	3.3	5.2
Total revenue rate / dinars	2156667	1773750	2795000
Average total production costs / dinars	2040942	1437267.54	2081714.46
Net revenue (profit) / dinars	115725	336482.46	713285.54
The profit difference from the actual production volume / dinars	-	220757.46	597560.54

Source: Calculated by researchers based on field survey data, and the results of cost function analysis.

The Total Marketing Costs of the Green Pepper Crop under the Protected Cultivation System

Table 3 indicates the total marketing costs needed to market one dunum of green pepper crop in the greenhouses in the study sample. The marketing costs amounted to about 13,244,000 Iraqi dinars. By dividing these costs into their different types, it is noted that the costs of each of the collection and sorting operations, the boxes needed for packing, transportation costs, and intermediaries' commissions, amounted to about 5,380,000, 3,795,000, 705,000, 3,364,000 Iraqi dinars. They represent 41%, 29%, 5%, 25%, of the total marketing costs, respectively, by reordering these costs in terms of relative importance, it is clear that the costs of collecting and sorting came in the first place in terms of their importance, followed by the cost of packing boxes, then commission costs obtained by intermediaries, and in the last place the costs of transporting the crop to its selling places.

Table 3. The total marketing costs of the green pepper crop under the protected cultivation system

Collection and sorting costs / dinars	Packing boxes costs / dinars	Transport costs / dinars	Sales commission / dinars	Total marketing costs / Iraqi dinars
5380000	3795000	705000	3364000	13244000

Source: Calculated by the researchers based on field survey data.

Estimating Marketing Margins, the Share of Farmer, and Marketing Intermediaries from Consumer Dinars for the Green Pepper Crop

By studying the marketing margins, referred to in Table 4, it is clear that the total marketing margins for the green pepper crop under the protected cultivation system in the study area amounted to about 627,500 Iraqi dinars per ton, of which the wholesaler gets about 206,500 dinars, while the retailer gets about 421,000 dinars. . The estimated results in Table 4 also indicate that the share of the farmer, wholesaler, and retailer of the price paid by the Iraqi consumer amounted to about 46%, 18%, and 36%, for each of them, respectively, which indicates a high share of intermediaries and customers from Iraqi consumer dinar.

Table 4. The average prices and total marketing margins of the green pepper crop under the protected cultivation system

Average crop prices / dinar - ton			Average marketing margins / dinar - ton			Iraqi consumer dinar distribution			
farm door	wholesale markets	single markets	wholesaler share	Single seller share	margins total	farmer ratio	wholesaler ratio	single ratio	brokers and customers ratio
537500	744000	1165000	206500	421000	627500	46%	18%	36%	54%

Source: Calculated by the researchers based on field survey data.

Estimating the Marketing Efficiency of the Green Pepper Crop under the Protected Cultivation System

Table 5 shows the marketing efficiency of one dunum of green pepper under the protected cultivation system in Baghdad governorate, where the percentage of marketing efficiency of the crop under study was about 76%. The decrease in the marketing efficiency of green pepper in the study sample from the required level can be attributed to the low performance of marketing functions, the high costs, and the high percentage of crop losses during marketing operations due to spoilage.

Table 5. Marketing efficiency of green pepper crop under protected cultivation system

Total marketing margins / dinars	Production costs / dinars	Total crop costs / dinar - dunum	Marketing efficiency ratio
627500	2040942	2668442	76.5

Source: Calculated by the researchers based on field survey data and the marketing efficiency equation.

CONCLUSIONS

i. The results of the study proved the validity of the research hypothesis, in that the green pepper farmers under the protected cultivation system in Baghdad province did not achieve the required level of both efficiencies; productive and marketing.

ii. The optimal and profit-maximizing production volume of the green pepper crop was about 3.3 and 5.2 tons for each of them, respectively, and the productive efficiency ratio for the study sample was about 83% and 53% compared to the optimal and profit-maximizing production volume for each of them, respectively, and the cost efficiency ratio was about 113 % compared to the optimal production volume, which means the high costs of crop production and the failure to optimally utilize economic resources in the production process, in addition to the failure to use modern technologies by the sample farmers in cultivating the crop.

iii. It turned out that the profits achieved according to the optimal and profit-maximizing production volume exceed the profits achieved according to the actual production volume of the study sample, with a difference of approximately 221 and 598 thousand Iraqi dinars for each of them, respectively, due to the high costs of crop production in the study area.

iv. The marketing efficiency of the green pepper crop reached about 76%, which is an unacceptable percentage. This indicates the poor level of marketing performance of the crop and its lack of modern marketing techniques and marketing services, in addition to the control of brokers and customers over the selling prices of the crop.

In light of the results of the study, the research recommends the need to follow modern production methods by the farmers of the study sample aim to increase the productive efficiency per dunum and achieving the optimal use of available resources in order to reach the optimal size of production and improve the efficiency of green pepper production under the protected agricultural system. The research also recommends the need to work to increase the marketing efficiency of the crop by increasing the efficiency of the marketing performance of marketing functions and services, and to follow modern marketing methods in collecting, sorting and packing, and transporting the crop to places of sale in the local markets.

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